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International application number: PCT/GB05/000856

International filing date: 04 March 2005 (04.03.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0405096.9
Filing date: 06 March 2004 (06.03.2004)

Date of receipt at the International Bureau: 24 May 2005 (24.05.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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Request for grant of a patent

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1.	Your reference	2003P09615 GB / P72 / EHE / JBO
2.	Patent application number *(The Patent Office will fill in this part)*	0405096.9
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	~~Oxford Magnet Technology Ltd.~~ Siemens Magnet Technology Limited (F20/77 ASPR) Wharf Road, Eynsham, Witney OX29 4BP
	Patents ADP number *(if you know it)*	6477760003
	If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM
4.	Title of the invention	A Cryogenic Hose Configuration
5.	Name of your agent *(if you have one)*	Edward Humphrey-Evans
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Siemens Shared Services Intellectual Property Department The Lodge, Roke Manor Romsey, Hampshire SO51 0ZN
	Patents ADP number *(if you know it)*	8439358001

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.			

7.	Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute *(see note f)*.	
8.	Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request? Answer YES if: *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.*	Yes

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Otherwise, answer NO (see note d).

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form.

Continuation sheets of this form	
Description	6
Claim*(s)*	1
Abstract	1
Drawing*(s)*	2

5 2

X

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translation of priority documents	
Statement of inventorship and right to grant a patent *(Patents Form 7/77)*	2
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application

Signature	Date
Edward Humphrey-Evans Intellectual Property Department	05.03.2004

12. Name and daytime telephone number of Person to contact in the United Kingdom

Edward Humphrey-Evans +44 1344 396807

DUPLICATE

A CRYOGENIC HOSE CONFIGURATION

Field of the Invention

The present invention relates to cryogenic assemblies for magnetic resonant imaging systems and the like. In particular, but not necessarily restricted thereto, the present invention relates to a cryogenic hose of the type which is employed to connect a cryogenic compression apparatus to a superconducting system such as a magnetic resonant imaging system.

Background to the Invention

In many cryogenic applications components, e.g. superconducting coils for magnetic resonance imaging (MRI), superconducting transformers, generators, electronics, are cooled by keeping them in contact with a volume of liquefied gas (e.g. Helium, Neon, Nitrogen, Argon, Methane), the whole cryogenic assembly being known as a cryostat. In order to operate a superconducting magnet, it must be kept at a temperature below its superconducting transition temperature. For conventional low temperature superconductors, the transition temperature is in the region of 10K, and typically the magnet is cooled in a container or vessel comprising a bath of liquid helium, commonly called a helium vessel, at 4.2K. For simplicity, reference shall now be made to helium, but this does not preclude the use of other gases. Services need to be run from the external environment at room temperature into the helium vessel, for monitoring purposes and to energize the magnet.

The cooling, liquefaction and/or further cooling of gasses such as helium require the generation of very low temperature refrigeration. Helium liquefies

at 4.21K. The generation of such a low temperature is very expensive and any improvements in cost and efficiency are very desirable. Pulse tube refrigerators are being increasingly used wherein pulse energy is converted to refrigeration using an oscillating gas. Such systems can generate refrigeration to very low levels, sufficient to liquefy helium. Gifford McMahon (GM) coolers are also used in such applications.

It will be appreciated that cryostats are not closed systems and have access necks to enable gas replenishment, service of the pulse tube refrigerator sleeve etc.. Furthermore the pulse tube system relies upon a supply of oscillating gas driven by a compressor system. As will be appreciated, the pulse tube system has input and output tubes between the compressor and the cryostat. Equally GM coolers have such input and output tubes. These pairs of gas transfer hoses conduct refrigerant gases from a compressor source to a cooling device within a cryostat. These hoses are constructed from convoluted hose to withstand the pressures. As the gas passes over the internal convolutions a whistling sound is created. This is typically most dominant in the low pressure hose, where the gas is more voluminous having expanded, as its energy and temperature have been increased during the energy transfer process of cooling in the cryostat.

This whistling noise is, at the minimum annoying for operatives of a cryostat, but can have untoward effects for patients in a magnetic resonant imaging system. It should be remembered that many magnetic resonant systems closely surround patients and this may make a patient fearful – if a patient is uncomfortable or disturbed during an imaging scan, then they may physically

move the part of their body being scanned resulting in a failure of the scanning operation. Furthermore, the acoustic disturbance can set up vibrational disturbances in the associated equipment. The cooling device's performance may be limited due to flow disturbance. The scanning device and other equipment operable to scan a patient/subject may also work less well with tolerances being larger than preferred.

Object of the invention

The present invention seeks to provide an improved cryogenic assembly. The present invention also seeks to reduce the sound levels produced by a cryogenic apparatus and the level of noise transferred through a gas transfer hose.

Statement of the Invention

In accordance with a first aspect of the invention, there is provided a cryogenic assembly comprising a cryostat, a compressor and a gas transfer hose, wherein the hose comprises a first axial conduit and a second circumferential conduit which surrounds the first conduit, one conduit being operable to transfer high pressure gases from a compressor to a cryostat and, the other conduit being operable to transfer low pressure gases from the cryostat to the compressor.

It has been found that the use of contra-flowing cryostat gases within a hose can reduce the overall noise produced by the hose. It is believed that the noise generated by one conduit is cancelled, to some extent, by the noise

generated by the other conduit. Once a system is installed and the minimum distance between a compressor and a cryostat determined, the length of the hose can be tuned to achieve a minimum noise level. Conveniently the first, inner conduit is operable to support transfer of the high velocity low pressure return gas from the cryostat, whereby the second conduit can reduce noise transmission by muffling the noise to a certain extent.

Brief description of the figures

The invention may be understood more readily, and various other aspects and features of the invention may become apparent from consideration of the following description and the figures as shown in the accompanying drawing sheets, wherein:

Figure 1 shows a prior art cryostat-compressor arrangement;

Figure 2 shows cross-sectional view of an embodiment of the invention; and

Figure 3 shows a cryostat-compressor arrangement in accordance with the invention.

Detailed description of the invention

There will now be described, by way of example, the best mode contemplated by the inventors for carrying out the invention. In the following description, numerous specific details are set out in order to provide a complete understanding of the present invention. It will be apparent, however, to those skilled in the art, that the present invention may be put into practice with variations of this specific.

Figure 1 shows a basic representation of a magnetic resonant imaging machine system 10 with a cryostat and imaging equipment 12 enclosing a patient 20. Gas transfer hoses 16 and 18 connect the compressor 14 with the cryostat 12.

Figure 2 shows a cross-sectional view through a gas transfer hose 22 made in accordance with the invention. An inner hose 30 defines an inner conduit within a second conduit 26 defined by hose 32. Braiding 34 surrounds the hose 32 for strength and abrasion resistance. Inner hose 30 is supported within the outer hose 32 by supports 28 which may be continuous supports – for example as made in an extrusion process – or may be individual supports placed at regular intervals. It is important, in the event that individual support are employed, that the supports are spaced such that they do not allow the inner hose to lie against the outer hose.

Figure 3 shows a schematic, part sectional representation of a hose in accordance with the invention. At the compressor 14, there is an outlet 42 and an inlet 44, providing connection to hose conduits 32a, 32 and 32b to supply compressed gases to the cryostat and receiving high velocity - low pressure exhaust gases from the cryostat via hose 30, respectively. Hose parts 32a and 32b connect to flanges 36, 38 associated with the outer conduit and compress outer tube 32 against a terminal/junction piece (not shown). Such junction piece preferably has rounded contours to enable a smooth flow from tube 32 to respective tubes 32a and 32b. At the cryostat 12 the tubes 30 and 32b connect with outlet and inlet ports associated with service neck 40. Alternatively, the inside tube may provide a conduit for the compressed gas, where it is likely to suffer less energy increase from the exhausted gas at low pressure.

Tests have been conducted using a twin hose system for comparative purposes in a Siemens OR64 magnetic resonance system, with a microphone mounted on a tripod 1.15m above floor level, 0.46m away from a magnet. The internal diameter of the 20m long hoses was 35mm, with the compressor being a Sumitomo model reference CW 71. At various PTR operating frequencies (1.56, 1.75, 1.8Hz), the signal levels at five positions were tested. Using a bidirectional hose, again of 20m length, with a first conduit having an inside diameter of 25mm and a second conduit having an inside diameter of 50mm, with a coaxial internal tube of outside diameter 35.1mm within, noise level differences as much as 3dB could be attained. Differences in heat exchange properties were also noticeable.

The present invention provides a neat solution to the issue of cable induced noise. In the setting up of a system it will be necessary to tune the length of a conduit to enable appropriate connection of services to a cryostat ad a minimum length of hose can be used as a guide to the actual length of tub required. Once a reduced noise level has been attained with the cryostat in operation, it may be worthwhile employing sound insulating foam about the hose to still further reduce noise transmitted by the hose.

Claims

1. A cryogenic assembly comprising a cryostat, a compressor and a gas transfer hose, wherein the hose comprises a first axial conduit and a second circumferential conduit which surrounds the first conduit, one conduit being operable to transfer high pressure gases from a compressor to a cryostat and, the other conduit being operable to transfer low pressure gases from the cryostat to the compressor.

2. A cryogenic assembly according to claim 1, wherein the first, inner conduit is operable to support transfer of the high velocity low pressure return gas from the cryostat.

3. A cryogenic assembly according to claim 1 or 2, wherein the cryogenic assembly comprises part of an MRI assembly.

4. A method of operating a cryogenic assembly comprising a cryostat, a compressor and a gas transfer hose, wherein the hose comprises a first axial conduit and a second circumferential conduit which surrounds the first conduit, the method steps comprising the passing through one conduit high pressure gases from a compressor to a cryostat and passing low pressure, high velocity from the cryostat to the compressor.

5. A cryogenic assembly substantially as described herein with reference to any one or both of figure 2 and figure 3.

ABSTRACT

A CRYOGENIC ASSEMBLY

The present invention relates to cryogenic assemblies for magnetic resonant imaging systems and the like. I~~, i~~n particular the present invention relates to a cryogenic hose which is employed to connect a cryogenic pump to a superconducting system such as a magnetic resonant imaging system. Known systems have a compressor for a refrigerant gas which passes through a pair of gas transfer hoses to conduct refrigerant gases to a cooling device within a cryostat. These hoses are constructed from convoluted hose to withstand the pressures. As the gas passes over the internal convolutions a whistling sound is created. This is typically most dominant in the low pressure hose, where the gas is more voluminous having expanded, as its energy and temperature have been increased during the energy transfer process of cooling in the cryostat. The present invention seeks to provide an improved gas transfer hose which, in operation, is quieter than hitherto. In accordance with a first aspect of the invention, there is provided a cryogenic assembly comprising a cryostat, a compressor and a gas transfer hose, wherein the hose comprises a first axial conduit and a second circumferential conduit which surrounds the first conduit, one conduit being operable to transfer high pressure gases from a compressor to a cryostat and, the other conduit being operable to transfer low pressure gases from the cryostat assembly to the compressor.

Figure 2

Figure 1

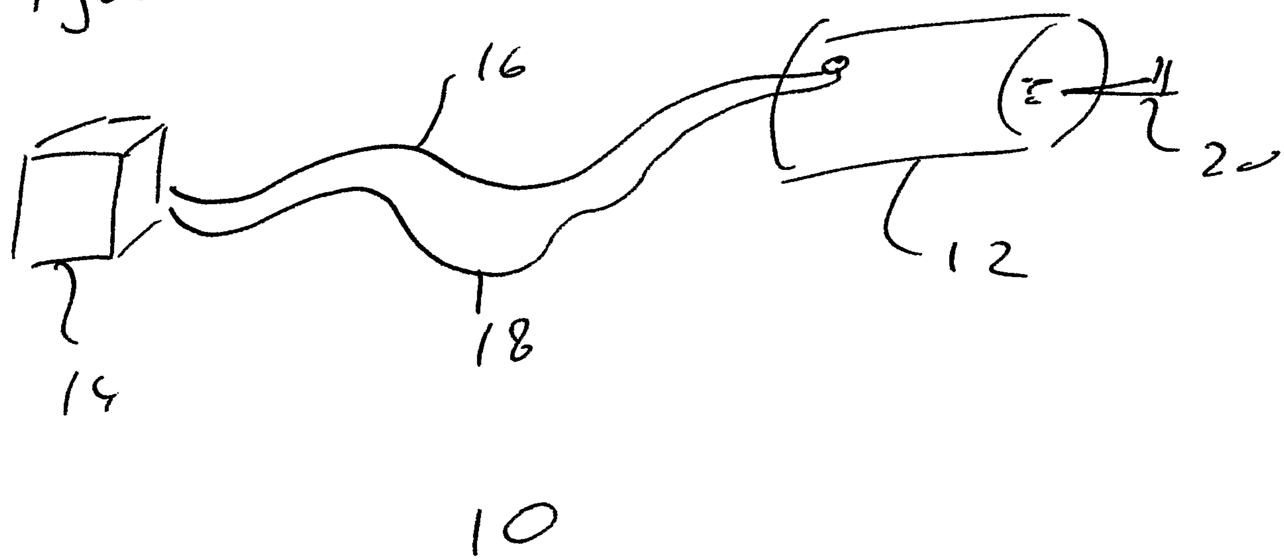

Figure 2

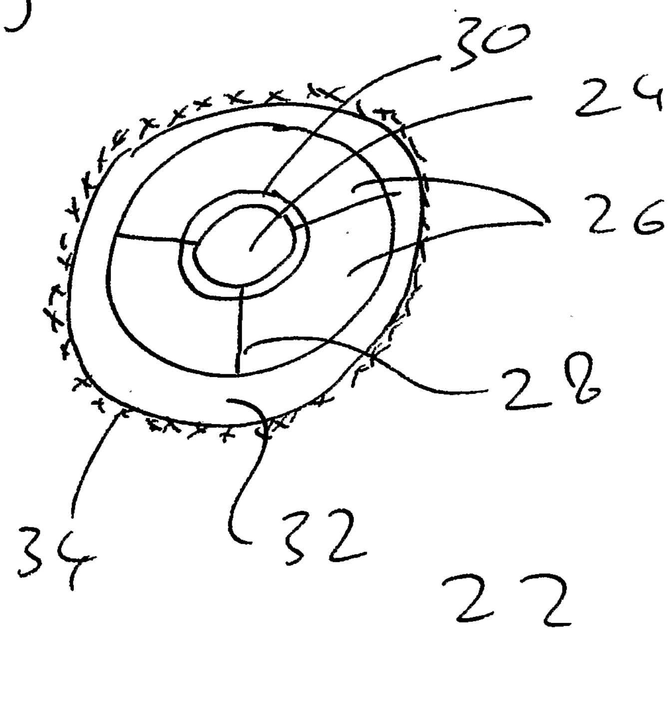

Figure 3